s^t signifies s transposed and conjugated.

A compensation pulse has to be devised for every frequency intermediate range (or subband) that is limited by two adjacent subcarriers and is located within the fade-out range.

Within this frequency intermediate range, the compensation pulse must reproduce the spectrum of the interference in the best possible way. For this purpose, the compensation pulse has to have, within this intermediate range, a transmission function that has still to be determined.

Outside this frequency intermediate range there has to be made a distinction between the intermediate ranges that are also located within the fade-out range and those intermediate ranges that are outside the fade-out range. Since the compensation pulses themselves act as interferences in other frequency bands, they have to be provided with the least possible transmission function for the adjacent channels located within the fade-out range in order not to occasion additional interferences there. In frequency ranges located outside the fade-out range, the demand for a highly attenuated transmission function is not as strict but it still has to be taken into consideration. The reason is that, on account of the deterministic interrelationship between the excitation of the compensation pulse and the data of the subcarriers used, constructive interferences leading to an excess of power may arise outside the fade-out range.

The data are to be demodulated in the receiver by means of a Discrete Fourier Transform (DFT). The DFT as well as the IDFT can be transferred to a transmultiplexer whose filters are arranged orthogonal to one another. In order to obtain that all the data be independent from each other after demodulation through DFT, all the transmission filters must be orthogonal. The prototype filter and the filters derived therefrom through shifting already meet this requirement. In addition, the compensation pulse must be orthogonal to the filters of those subcarriers that transmit useful data. The discrete compensation pulses need not be orthogonal to each other.

As already mentioned herein above, the compensation pulse has to best approximate a

transmission function that will be more fully explained herein after within the frequency intermediate range for which it was devised. The spectrum within the intermediate range needs to be as similar as possible to the spectrum of the interference.

The interference is composed of the superimposition of several side lobes, the side lobes with the greatest amplitude maximum having the strongest interfering influence. On this account, the nominal transmission function of the compensation pulse is composed of the transmission functions of the two large side lobes. Outside its subband, the nominal transmission function equals zero.

If the compensation pulse for the subband $k \cdot 2\pi/M \leq \theta < (k+1) \cdot 2\pi/M$ is to be devised, the two neighboring pulses $H_{k-1}(e^{j\theta})$ and $H_{k+2}(e^{j\theta})$ are mainly responsible for the interferences in the frequency intermediate range considered, as is represented in Fig. 13 for M=16 and k=2 and in the amplitude of the transmission functions $H_1(e^{j\theta})$ and $H_4(e^{j\theta})$. The transmission functions for the two subcarriers k-1 and k+2 read

$$H_{k-1}(e^{j\theta}) = \frac{1}{\sqrt{M}} \frac{\sin\frac{M}{2}\left(\theta - \frac{2\pi}{M}(k-1)\right)}{\sin\frac{1}{2}\left(\theta - \frac{2\pi}{M}(k-1)\right)} e^{-j\left(\theta - \frac{2\pi}{M}(k-1)\right)\frac{M-1}{2}} \qquad (10)$$

$$H_{k+2}(e^{j\theta}) = \frac{1}{\sqrt{M}} \frac{\sin\frac{M}{2}\left(\theta - \frac{2\pi}{M}(k+2)\right)}{\sin\frac{1}{2}\left(\theta - \frac{2\pi}{M}(k+2)\right)} e^{-j\left(\theta - \frac{2\pi}{M}(k+2)\right)\frac{M-1}{2}} \; . \qquad (11)$$

In the frequency range of $0.25 \leq \theta/\pi < 0.375$ of concern, the side lobes of these two transmission functions were assumed as the main source of interference. The transmission functions located farther away participate accordingly less in the interference, their part in it being neglected in calculating the nominal transmission function.

The maximum of the right and left main side lobe of $H_{k-1}(e^{j\theta})$ and $H_{k+2}(e^{j\theta})$ occurs at $\theta = (2\pi/M)$

(k+0.5). Substitute at this place yields

$$H_{k-1}(e^{j\theta})\Big|_{\theta=\left(k+\frac{1}{2}\frac{2\pi}{M}\right)} = \frac{1}{\sqrt{M}}\frac{-1}{\sin\frac{3\pi}{2M}}e^{-j\frac{3\pi}{2}\left(1-\frac{1}{M}\right)} \tag{12}$$

$$H_{k+2}(e^{j\theta})\Big|_{\theta=\left(k+\frac{1}{2}\frac{2\pi}{M}\right)} = \frac{1}{\sqrt{M}}\frac{-1}{\sin\frac{3\pi}{2M}}e^{j\frac{3\pi}{2}\left(1-\frac{1}{M}\right)}\,. \tag{13}$$

As can be seen in Fig. 13, the two side lobes have the same amplitude maximum but a different phase. The phase difference of the two side lobes at $\theta = (2\pi/M)\,(k+0.5)$ is

$$\Delta\phi = \arg\left\{H_{k+2}(e^{j\theta})\right\} - \arg\left\{H_{k-1}(e^{j\theta})\right\}\Big|_{\theta=\left(k+\frac{1}{2}\frac{2\pi}{M}\right)} = 3\pi - \frac{3\pi}{M}\,. \tag{14}$$

For this reason, the nominal transmission function

$$S(e^{j\theta}) = \begin{cases} -\frac{1}{2}\left(e^{j\frac{\Delta\phi}{2}}H_{k-1}(e^{j\theta}) + e^{-j\frac{\Delta\phi}{2}}H_{k+2}(e^{j\theta})\right) & \text{for} \quad k\frac{2\pi}{M} \le \theta < (k+1)\frac{2\pi}{M} \\ 0 & \text{otherwise} \end{cases} \tag{15}$$